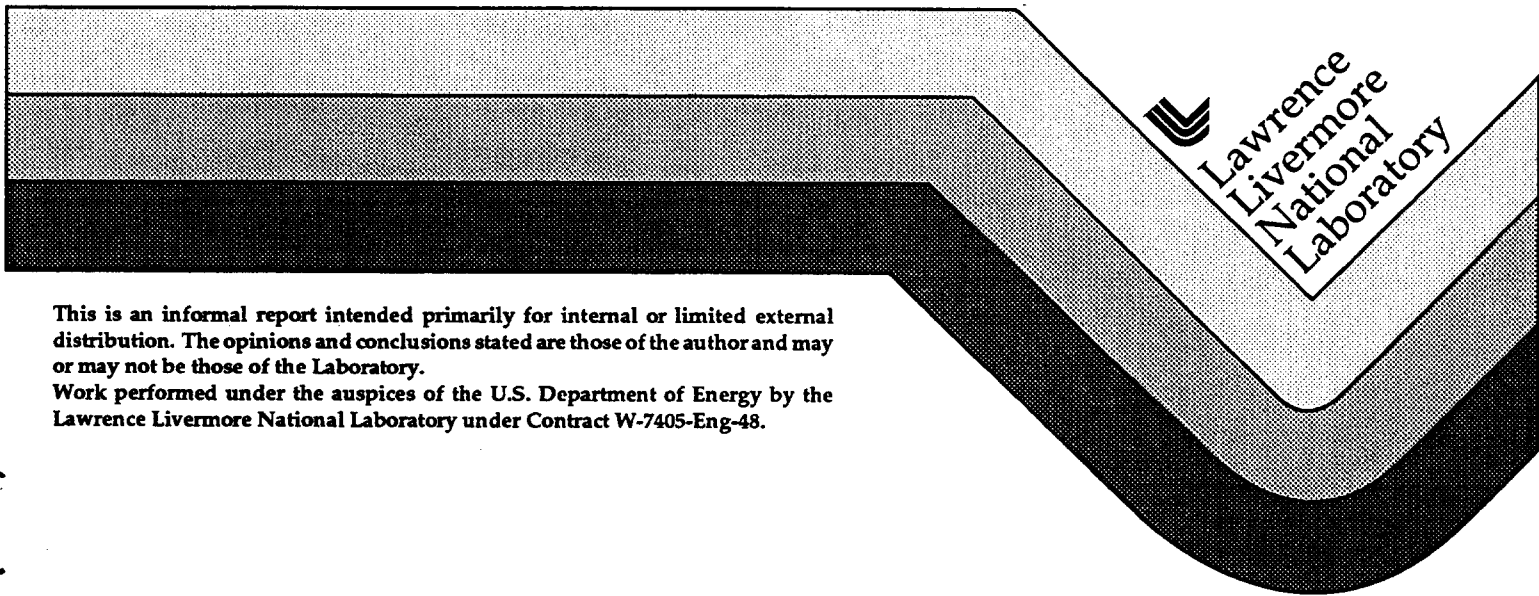


CALIFORNIA ENERGY FLOW IN 1993

I. Y. Borg
C. K. Briggs

April 1, 1995



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ABSTRACT

Energy consumption in the state of California decreased about 3% in 1993 reflecting continuation of the recession that was manifest in a moribund construction industry and a high state unemployment that ran counter to national recovery trends. Residential/commercial use decreased slightly reflecting a mild winter in the populous southern portion of the state, a decrease that was offset to some extent by an increase in the state population. Industrial consumption of purchased energy declined substantially as did production of self-generated electricity for in-house use. Consumption in the transportation sector decreased slightly. The amount of power transmitted by the utilities was at 1992 levels; however a smaller proportion was produced by the utilities themselves. Generation of electricity by nonutilities, primarily cogenerators and small power producers, was the largest of any state in the U.S. The growth in the number of private power producers combined with increased amounts of electricity sold to the public utilities set the stage for the sweeping proposals before the California Public Utility Commission to permit direct sales from the nonutilities to retail customers.

California production of both oil and natural gas declined; however, to meet demand only the imports of natural gas increased. A break in the decade-long drought during the 1992-1993 season resulted in a substantial increase in the amount of hydroelectricity generated during the year. Geothermal energy's contribution increased substantially because of the development of new resources by small power producers. Decline in steam production continued at The Geysers, the state's largest field, principally owned and managed by a public utility. Increases in windpower constituted 1-1/2% of the total electric supply- up slightly from 1992. Several solar photo voltaic demonstration plants were in operation, but their contribution remained small.

INTRODUCTION

For the past seventeen years energy flow diagrams for the State of California have been prepared from available data by members of the Lawrence Livermore National Laboratory.¹ They have proven to be useful tools in graphically expressing energy supply and use in the State as well as illustrating the difference between particular years and between the State and the U.S. as a whole.

As far as is possible, similar data sources have been used to prepare the diagrams from year to year and the same assumptions^{1a-1c} concerning conversion efficiencies have been made in order to minimize inconsistencies in the data and analyses. A reexamination of transportation efficiencies,² especially those associated with the highway vehicles, has led to the downward revision of the percent used in the figures presented here for 1992 and 1993. Sources of data used in this report are given in Appendix B and C. We continue to see differences in specific data for a given year reported by our principal sources — U.S. Department of Energy, Energy Information Administration and the California Energy Commission. In particular, reported data on supply and usage in the industrial and commercial/residential end-use categories have varied between reporting agencies. However revisions in the data subsequently published by both principal sources have brought them into closer agreement and are reflected in revised energy flow diagrams, one of which is included here.

CALIFORNIA ENERGY FLOW DIAGRAMS

California energy flow diagrams for 1993 and 1992 are shown in Figs. 1 and 2, respectively. For comparison the U.S. energy flow for 1993 is shown in Fig. 3.² Energy sources are shown on the left and energy consumption is shown on the right. The energy balance between the two is given in Appendix A. Also shown on the right of Figs. 1, 2, & 3 is the division between “useful” and “rejected” energy based on estimates of conversion efficiencies in the various end-use sectors. “Rejected energy” consists primarily of heat losses. Conversion and plant losses at electric utility generation stations burning fossil fuels are a matter of record, but inputs to total transmitted electricity such as nuclear, geothermal power, etc. are associated with estimated efficiencies of the conversion process to electricity. These estimates vary from 90% in the case of hydroelectric power to 18% for geothermal energy. This year we have revised our estimate of efficiency for the transportation sector from 25 to 20% after a review of the subject.² The estimates of conversion efficiencies are given in Appendix D, and their rationale can be found in Refs. 1b, 1c and 2.

CALIFORNIA ENERGY FLOW -1993

TOTAL CONSUMPTION 7000×10^{12} Btu

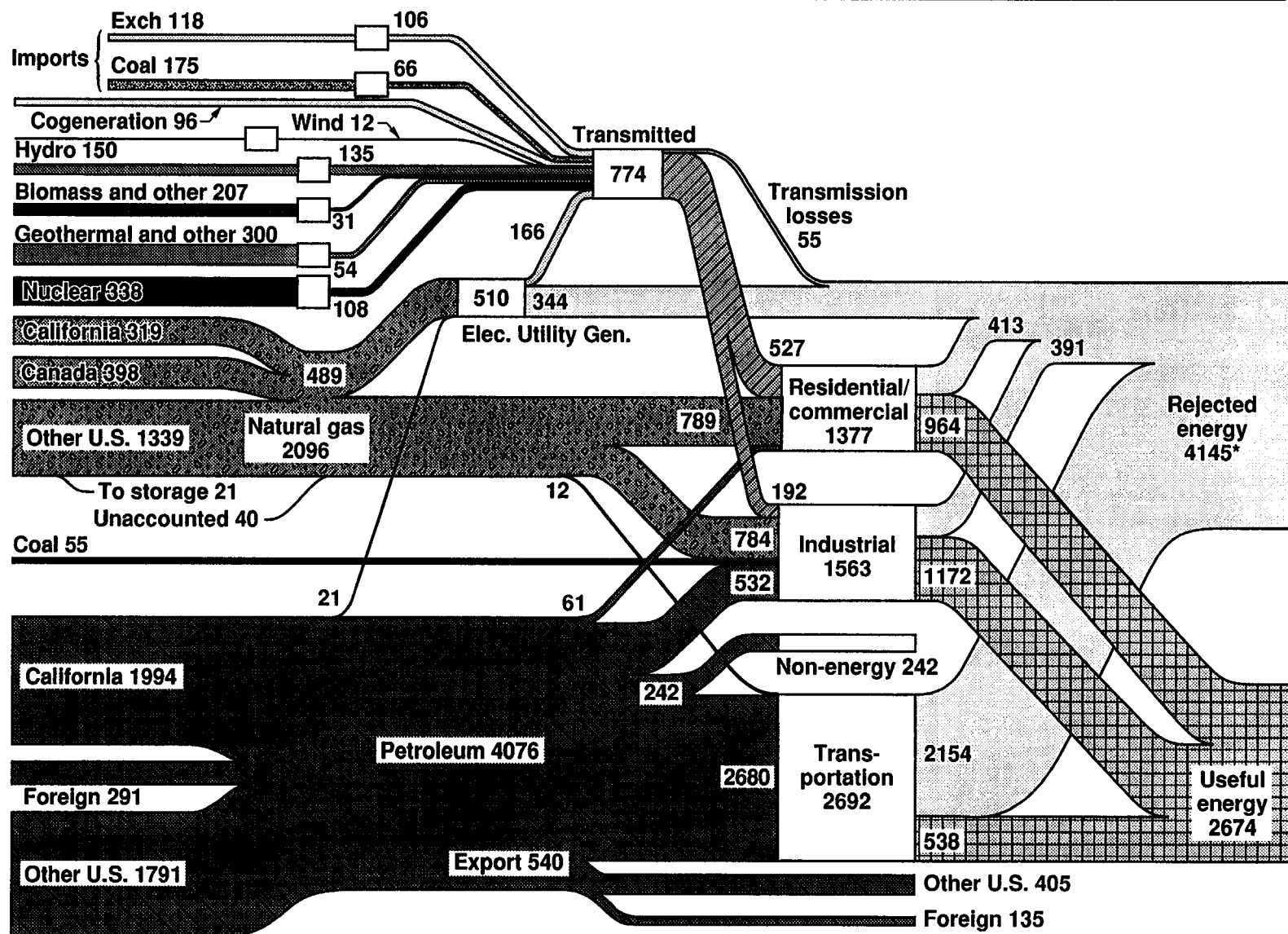


Figure 1

CALIFORNIA ENERGY FLOW -1992

TOTAL CONSUMPTION 7200×10^{12} Btu

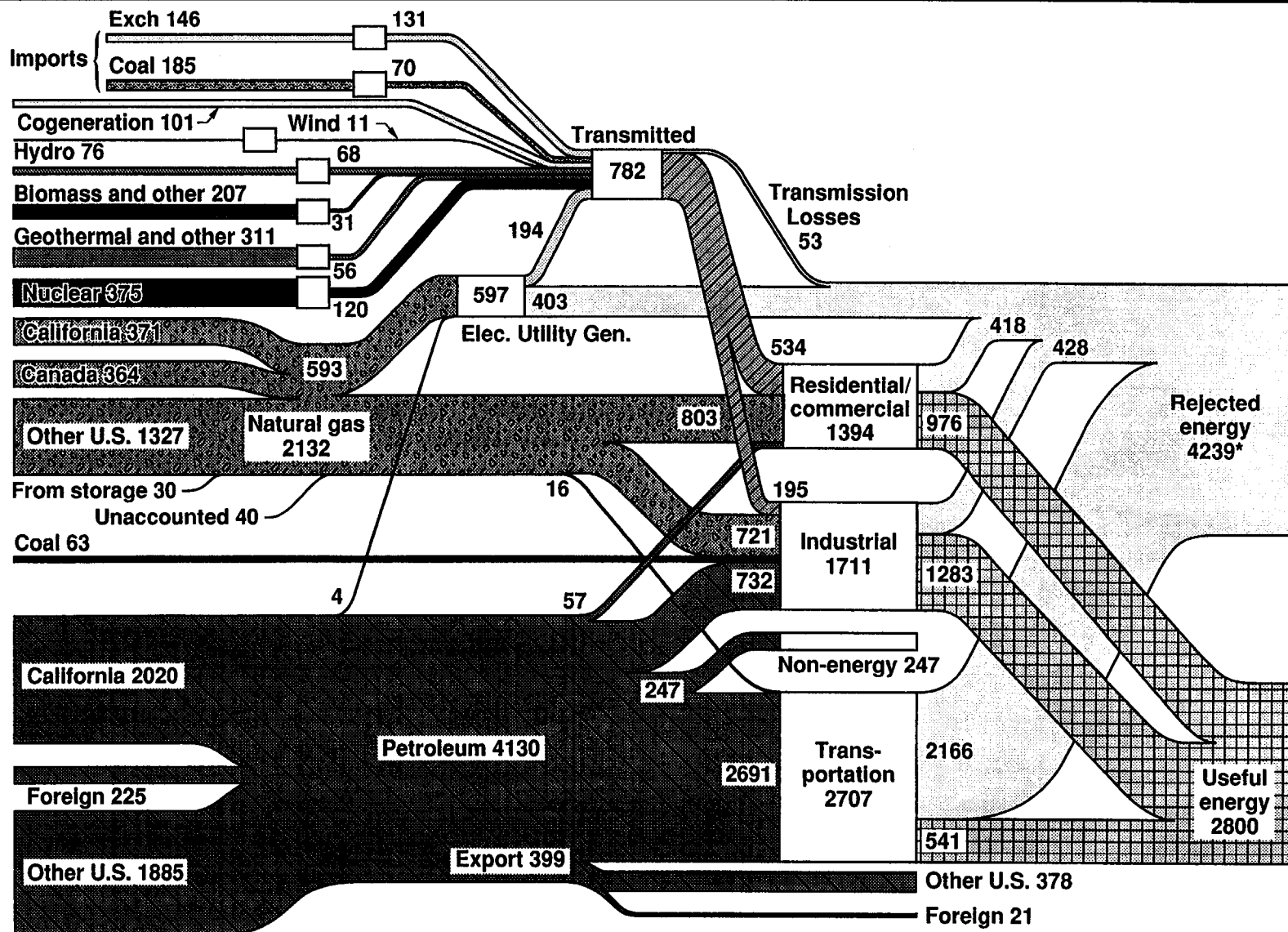


Figure 2



ected
nergy
46.9

seful
nergy
31.0

The box separating the energy source from the final electrical output represents the conversion process. In all cases the quantities associated with the energy source are calculated based on the assumed conversion efficiencies. While it is desirable to minimize the number of assumptions in preparing an energy flow diagram, it is also desirable to express as closely as possible the energy content of the sources used during the year. In this way it is possible to see at a glance which energy sectors are associated with the greatest conversion losses and thus the largest targets for potential technological improvements in conversion efficiencies.

Power from cogenerators that is sold to utilities is shown in the figures as inputs to total transmitted electricity and appear without a box (representing the conversion process) that ordinarily would appear between the energy content of the fuel and the final product. In this instance, electric conversion losses are included in "rejected energy" from the industrial sector. Not shown in the flow diagrams is the amount of electricity used "in house" by the cogenerators and self generators, but an estimate is given in the section on *Nonutility generation*. Thus the amount of electricity consumed by the industrial sector, 192×10^{12} Btu in Fig. 1, represents purchases from the utilities only.

Starting in 1992 the energy flow diagrams shown in Figs. 1 and 2 reflect losses associated with electric conversions by the small independent power producers. Their collective sales of electricity to the utilities have been part of the public record and included in the charts; however heretofore the fuels or type of energy used to produce electricity have not been available in a timely manner. Hence it has not been possible to estimate conversion losses. Generally the small power producers utilize energy sources, such as biomass or geothermal, whose conversion efficiency to electricity is lower than the conventional fossil fuels used for power production. Efficiency of fossil-fueled electric utility boilers is approximately 33% whereas the average efficiency of all biomass plants operated by nonutilities is approximately 12%³ and 18% for geothermal plants.

Electricity consumed by the residential/commercial end use sectors shown in Figs. 1 and 2 include an "other" category of consumption tabulated by the U.S. Department of Energy. It includes street and highway lighting and other sales to public authorities as well as sales to public railroads and railways. Lacking a breakdown in the "other" category (27×10^{12} Btu's in 1993) it is not possible to indicate how much of this electricity properly belongs in the transportation sector.

CALIFORNIA'S ENERGY FLOW IN 1993 COMPARED TO 1992

The economy

For the second year California did not experience the same economic upturn of the nation as a whole. Most economic indicators pointed to a continued state recession (Table 1). Notable was a high average unemployment rate of 9.2% compared to a national average of 7.1%.⁴ At year-end

unemployment had dropped to 8.7% suggesting some improvement in the situation. This indicator is considered to be the broadest, most currently available measure of regional economic activity. Since reaching a peak in mid-1990, California has lost an estimated 900,000 jobs making this period the longest and deepest downturn in employment since World War II.⁵ The loss of jobs is attributed to contraction of the defense industry within the state (especially the aerospace industry) and to a lesser extent the “downsizing” of corporations driven by efforts to remain competitive by cutting overhead costs and staffs. The shrinking of the defense industry in the state is expected to continue with the closure of many more federal installations such as Norton Air Force Base in San Bernardino County, Moffett Field, The Presidio, and Mare Island Naval Shipyard near San Francisco, Fort Ord in Monterey County and Castle Air Force Base in Merced County.

Table 1. Selected economic data for California - 1993⁴

<u>Indicator</u>	<u>Percent change from 1992</u>
Unemployment	+1.1
Housing units authorized	-13.2
New auto registrations	+2.7
Total taxable sales	-0.1
Corporate profits before taxes	+2.8est
Personal income	+2.4
Consumer price index	+2.6

Another indicator of economic activity, the number of new construction projects started during the year (Table 2), similarly points to a continued recession through 1993 in the state. Home prices throughout the state fell 3.7% in 1993 compared to a 1.9% gain nationwide.⁶

Table 2. Construction authorized by permit - 1993⁴
(Value in Millions of Dollars)

<u>Year</u>	<u>Residential</u>	<u>Nonresidential</u>	
		Commercial	Other*
1988	26,361	6,569	7,592
1989	27,790	6,159	7,507
1990	20,686	5,270	7,466
1991	15,056	3,374	6,247
1992	14,451	2,472	5,683
1993	12,932	2,137	5,420

*Other consists of all other categories including additions and alterations of \$100,000 or more.

The CA Department of Finance reported that California's population grew by less than 500,000 or 1.5% to 32 million in 1993.⁷ As of January 1, 1994 there was a net gain of only 65,000 people from migration during the previous twelve months, the lowest number since record keeping began in 1940-41. All other factors being equal, the population increase presages a modest increase in energy demand for the year.

Energy Consumption

Overall energy use in California fell in 1993. A breakdown of the major fuels consumed and the principal end-use sectors consuming those fuels is given in Table 3 for the last decade. Consumption in the principal end-use sectors (residential/commercial, industrial and transportation) either remained at 1992 levels or declined.

An unusually large decrease in fuel usage in 1993 was registered by the industrial sector and the related non-energy sectors (Table 3). What is called non-energy here is consumption to produce products such as petrochemicals, fertilizers, waxes, lubrication oils, asphalt, etc. These products are not burned to produce energy. In California asphalt production which serves the road and highway construction industry is the largest contributor to the total. The decline in industrial consumption reflects the on-going recessionary atmosphere that prevailed in the state during the year. Use of oil products by the industrial sector was primarily affected, but use of natural gas and purchases of electricity from the utilities fell as well (Fig. 1). Although the amount of electric power produced and used in-house by the industrial community is not included in this total, the fossil fuels used to produce that power are included. The drop in the amount of natural gas used by the industrial sector, the fuel-of-choice of self generators, suggests that the amount of electricity generated by industries for their own use declined as did the amount of power purchased from the utilities (shown in Figs. 1 & 2). This is verified by information provided by the U.S. Department of Energy discussed in a later section titled *Nonutility Generation*.

Use of transportation fuels was lower but close to 1992 levels due to offsetting trends more completely explored in the TRANSPORTATION FUELS section that follows. Residential/commercial consumption for the year declined a few percent as did use of natural gas by that sector. It is likely that a diminished demand for space heating because of a mild winter in populous Southern California (Table 4) more than offset the modest increase in population during the year. Natural gas is the principal fuel used for residential and commercial heating in California; both fuel oils and electrical resistance heating are only important in isolated areas lacking access to pipeline gas.

Table 3**Comparison of Annual Energy Use in California**(in 10¹² Btu)

	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>
Natural Gas	1769	1865	2034	1697	2091	1932	2087	2069	2089	2132	2096
Crude Oil (less exports)	3329	3477	3580	3601	3591	3899	4015	3884	3731	3731	3536
Utility electric sales	622	700	673	697	718	744	757	763	713	729	719
Residential/Commercial	1268	1176	1325	1224	1325	1350	1403	1474	1442	1394	1377
Industrial	1395	1493	1648	1456	1439	1557	1646	1560	1616	1711	1563
Non-energy	183	221	185	203	292	235	237	252	245	250	242
Transportation	2313	2464	2384	2499	2564	2715	2781	2817	2800	2707	2692
Total Energy Consumption [†]	5900	6200	6400	6200	6600	6750	6950	6900	6800	7200	7000

[†] Total is not sum of above figures because of rounding and inclusion of losses associated with conversion to electrical energy. Prior to 1992 losses associated with small power producers selling electricity to utilities were not included in Total Energy Consumption.

Table 4. Weather Comparison, 1968 - 1993
(Annual Heating Degree Days**)

	San Francisco Federal Office Building	Los Angeles Civic Center	San Diego Lindbergh Field
1968	2942	850	1052
1969	3066	1032	1145
1970	3006	941	1137
1971	3468	1424	1657
1972	3240	918	1166
1973	3161	1066	1137
1974	3182	1084	1123
1975	3313	1548	1416
1976	2665	1128	793
1977	2888	911	747
1978	2599	1208	736
1979	2545	1160	902
1980	2799	597	590
1981	2819	506	573
1982	3195	975	913
1983	2386	602	623
1984	2648*	704	713
1985	2486*	921	1079
1986	1842*	473	843
1987	2150*	979	1201
1988	2194*	867	1102
1989	2526*	844	1068
1990	2340*	839	1172
1991	2422*	879	1212
1992	1718*	705	866
1993	2071*	680	948

As noted earlier, for the first time we have included estimates of conversion losses of small power producers (biomass, geothermal, coal coke, small hydropower) in tallies of energy consumption and in energy flow diagrams (Figs. 1 and 2). This addition necessarily results in larger totals for energy consumption (Table 3) than otherwise would be reported and invalidates comparisons of total energy consumption in the years prior to 1992. It should be noted, however, that the contributions of the group were small until about 1985.

TRANSPORTATION FUELS

Consumption

Use of all transportation fuels decreased slightly in 1993 (Tables 3 and 5). Gasoline sales increased approximately 1% reflecting an increase in both the number of licensed drivers and the number of miles traveled on the state's highway system.⁸ The latter rose for the nineteenth consecutive year.⁸ Also impacting gasoline usage was the slight drop in the efficiency of the nation's passenger car fleet in both 1992 and 1993. In 1993 it was estimated to average 21.64 miles per gallon nationwide.⁹

While sales of jet fuels grew with increased number of commercial air flights, sales of aviation gasoline fell for the fifth consecutive year.⁸ The slight decrease in sales of highway diesel fuels may reflect both the economic recession that prevailed in 1993, the boycott of some truckers who sought out-of-state supplies in preference to the new reformulated diesel oils that became standard output of California refineries at the end of the year (See Vehicle Emission Standard Section) or both factors. The sale of vessel bunkering fuels at California ports is continuing to be affected by new state taxes imposed in mid-1991.

Ridership on almost all types of public transit systems fell substantially in 1993. Intercity bus travel as reported by Greyhound Lines Inc. fell 45%; annual bus transit as reported by eleven major operators was down ~6%; intercity and commuter rail ridership was spotty with the largest system, Bay Area Rapid Transit with 73.5 passengers in 1993, showing 0.3% drop in the number of passengers.⁸

Vehicle Emission Standards

On October 1, 1993 both the state and the federal reformulated diesel fuel regulations took effect. The California Air Resources Board (CARB) standards for diesel are similar but more stringent than the Environmental Protection Agency's. (The reformulated gasoline regulations are not scheduled for implementation until January 1, 1995.) The objectives are to reduce emissions of SO₂, NO_x and particulate matter under 10 microns in size; however at least three California refiners

Table 5. California Transportation End Use
(in 10¹² Btu)

	1987	1988	1989	1990	1991	1992	1993
Net gasoline*	1576	1612	1630	1664	1712	1670	1681
Net aviation fuel	390	427	458	475	476	510	520
Taxable diesel fuel -public highways	174	244	265	253	246	256	253
Rail diesel	30	26	30	31	33	30	27
Net bunkering fuel	347	357	348	344	288	202	193
Military	28	29	30	29	26	23	7
Natural gas-pipeline fuel	13	20	20	21	19	16	12
Natural gas vehicular	-	-	-	0.004	0.01	0.03	0.27
Total**	2565	2715	2781	2817	2800	2707	2693

* As of January 1, 1992 leaded gas was no longer produced at California refineries.

** Some electricity is used for mass transit; however the amount is not monitored on a state-wide basis and hence does not appear in this table or in Figs. 1 and 2.

Source: Fuel and Kerosene Sales, DOE/EIA, 1993; Quarterly Oil Report, Fourth Quarter 93 (Net gasoline and aviation fuel), California Energy Commission, Sacramento, CA; Natural Gas Annual-1993 DOE/EIA-0131(93) Table 52, Department of Energy, Washington, DC (October 1994).

(Exxon, Mobil and Shell) initially declined to produce a diesel that met CARB standards. A combination of added refining costs, shortages of reformulated diesel and a new federal highway tax of 4.3 cents per gallon also imposed on October 1 led to a large price increase in the price of diesel in the first few months of the program; the average weekly price of diesel fuel per gallon in California jumped 45 cents per gallon; however as the supply met demand the price declined.¹⁰

Escalating prices were not the only consumer complaint. Within weeks of appearance of the reformulated fuel at truck stops, truckers began complaining of malfunctioning engines. Subsequently almost every class of diesel-burning vehicle was on record as having problem with fuel pumps and seals.¹¹ Truckers that were able began refueling out-of-state. Governor Pete

Wilmer refused to suggest the regulations on appeal by the California Trucking Association, and

Pete Wilson signed into law a bill that provides remuneration to vehicle owners whose engines were damaged by the cleaner-burning diesel fuel. A Task Force appointed by the Governor concluded that the problem affected a relatively small percentage of the state's vehicles, and the regulations still stand. The two class action suits against the refiners are still pending. Ironically the money for the reimbursements will come from a special fund financed by penalties paid by oil refiners who did not meet a state-imposed deadline for producing the cleaner-burning fuel.¹²

There was growing pressure during 1993 on the CARB to modify its 1990 ruling that 2% of all the new cars sold in the state in 1998 (about 40,000) be "zero emission" vehicles, presumably powered by electricity; the mandated share is to rise to 10% in 2003. The oil industry and the auto industry are foremost opponents of the ruling, but nevertheless the latter industry has launched substantial programs designed to meet the requirement with battery-operated vehicles. The CARB has shown no inclination to back down, citing the extensive R & D on electric vehicles and notable advances in battery technologies that have taken place since the requirement became law.¹³ Critics argue that if the intent of CARB is to eliminate air pollution from some part of the state's highway vehicles, it is taking the wrong tack. They point out that unless the requisite electricity to charge the car batteries is derived from out-of-state sources, it will almost certainly be generated by burning fossil fuels within the state with attendant air pollution.

OIL AND GAS PRODUCTION

Oil Production

California's oil production continued its inevitable decline although it maintained its fourth place position in the nation as a whole behind Texas, Alaska and Louisiana with production of 343.7 million barrels in 1993. The largest declines were registered in onshore fields, particularly at the South Belridge field near Bakersfield where production was down 3.6 million barrels. Nonetheless it was the second largest producing field in the state.¹⁴ A bright spot in the onshore production picture was a substantial increase (1.2 million barrels) in output for the fifth consecutive year at the Lost Hills oil field, also in Kern County, as a consequence of doubling of enhanced oil

The giant Point Arguello field 10 miles offshore was expanded 35,000 barrels per day when permission to off-load crude oil to tankers from offshore platforms was obtained January 1, 1993 from the California Coastal Commission.¹⁶ The permit expires in three years at which time the owners are required to have built a direct pipeline to Los Angeles refineries. The permission followed many years of controversy concerning movement of the oil from offshore production platforms to shore. In order to start production, Chevron had been shipping Point Arguello oil to shore via an existing, small capacity underwater pipeline thence by pipeline to northern California where it was shipped by tanker to Los Angeles transiting the Santa Barbara coast en route. The Santa Barbara County officials thus realized little advantage from their long standing opposition to Point Arguello crude oil being transported directly to refineries in tankers. With expected additional production from new offshore platforms in the Santa Ynez Unit in the Santa Barbara Channel that will also need transportation to refineries, there has been active interest in construction of the proposed new line by several pipeline companies.¹⁷

Natural Gas Production

In 1984-1985 the volume of gas produced in association with oil production was similar to the amount produced in gas fields unassociated with oil production. In the interim both volumes have declined, but "nonassociated" gas has shown the largest decrease reflecting the steadily declining contributions from offshore fields. Natural gas produced in 1993 (317.6 Bcf) was less than half of that produced in the record setting year of 1968 (714.9 Bcf).¹⁴ Continued decline in California production is anticipated.

OIL AND NATURAL GAS SUPPLY

Oil Supply

The state has relied on California production to supply 50-55% of demand for several decades. In 1973 the remainder was supplied principally by foreign sources with only 10% being supplied by other states. By contrast, in 1993 the largest source of out-of-state crude oil and refined products was the state of Alaska; foreign oil entering California refineries fell to about 5% of demand. The turning point was the opening of the Trans-Alaskan Pipeline from the super-giant Prudhoe Bay field on the North Slope of Alaska to Valdez on Prince William Sound in 1977. While that supply augmented by subsequently discovered and developed oil resources on the North Slope has been more than adequate to meet California's growing demand for oil, the Prudhoe Bay field in Alaska has started a slow decline in production which is expected to increase to 6% per year to the year 2000 and thereafter to 15% per year.¹⁵ By the turn of the century the projected cumulative decrease in the supply of both California and Alaskan crude oil promises to force

California to turn to foreign sources for the bulk of its oil. The possibility of significant new discoveries on portions of the North Slope, Alaska that are currently accessible to drilling or that the Arctic Wildlife Refuge will be opened for exploration of its estimated more than 3 billion barrel resource are considered remote by most analysts.

Natural Gas Supply

Slightly less than two-thirds of the supply of natural gas in California derives from southwestern states, principally New Mexico and west Texas. Local state production provides 17% as also do imports from Canada. The supply to the State was more than adequate although the long lived "gas bubble," which is the difference between maximum feasible gas capacity and actual deliveries, was declined to about 4%.¹⁸ There was a sharp increase in wellhead prices in 1993 (\$2.02/Mcf up sharply from \$1.74/Mcf the previous year) driven by the demands of the very cold winter of 1993-1994 in the U.S.

Completed in 1993 was Pacific Gas Transmission Corp.'s 840-mile pipeline to deliver 903 million cf/day of Canadian gas to western markets. It provides 755 million cf/day of firm capacity to Northern and Southern California and 148 million cf/day to the Northwest states.¹⁹ This pipeline is one of four, new or expanded lines into the State that have been completed in the 1991-1993 period. Collectively they have increased pipeline capacity by about 50%. Increase in demand for natural gas has come from all sectors; however the largest increase in demand has been driven by pollution laws that have impacted heavy oil producers who formerly burned raw crude oil and heavy refined oils to raise steam for steam flooding in California's heavy oil fields. Another growing group of large gas users are electric cogenerators and self generators who turn to gas for a

offering other inducements such as reliability and security of supply in order to keep them as customers.

ELECTRICAL POWER

Source of Supply

Electricity distributed by California utilities derives from numerous sources — imports from out-of-state generators — principally from the southwest U.S., utility generators utilizing fossil fuels, hydropower, geothermal energy and nuclear reactors, and from purchases from nonutility generators using a variety of fuels (Table 6). Utility generating capacity by fuel source is given in Table 7.

Table 6. Sources of California Utilities' Distributed Electricity- 1993

<u>Source</u>	<u>Net electrical energy</u> (trillion Btu)	
Imports		172
Out-of-state coal facilities	66	
Purchases	106	
Fossil fuels		166
Natural gas	159	
Oil	7	
Nuclear power (in-state)		108
Hydropower		135
Geothermal power		54
Windpower		12
Cogeneration		96
Biomass, solar, & coal		31
TOTAL		774

Table 7. California Utility Electrical Generating Capacity²⁰

<u>Primary energy</u> <u>source</u>	<u>Capacity</u> (GWe)
Petroleum	1.93
Gas	22.91
Water	13.45
Nuclear	4.31
Other (principally geothermal)	1.72
TOTAL	43.77

* Summer capability as of December 31, 1993

Nuclear Power

The contribution from the state's two nuclear installations (San Onofre, San Diego Co. and Diablo Canyon, San Luis Obispo Co.) fell 10% in 1993. Diablo Canyon, the subject of great safety concerns a decade ago, however, produced a record amount of power and the two ~1000 MW units operated at a combined 89% capacity²¹ compared to an industry average of 70.5%.²² Commercial operation started in 1985-1986.

The rate settlement with the California Public Utilities Commission effective mid-1988 ties the return on investment in the Diablo Canyon nuclear plant to the amount of electricity generated rather than to the traditional cost-based rate determinations. In 1993 the return to Pacific Gas and Electric Co., the owner, was 11.6 cents per kwh — up from 7.8 cents per kwh in 1988 reflecting increased output over the period. This has been accomplished by a variety of efficiency measures, the most efficacious being the reduction in refueling time from 129 and 82 days for the two units, respectively, in 1988 to 59 and 57 days for the two in 1993. Ninety two days is average for comparable plants. As each unit produces about \$3 million of revenues per day at full operating power, shortening of the refueling time has increased PG&E's revenues substantially.¹⁹ The plant has been on the Nuclear Regulatory Commission's list of best plants for five consecutive years.

Hydropower

Noteworthy in 1993 was the doubling of the contribution of hydropower (Compare Figs. 1 and 2). The 1992-1993 winter rains restored state reservoirs to near capacity levels representing a respite from the drought that had prevailed in the previous years.

Nonutility Generation

Also noteworthy was the large contribution to supply made by nonutility generators. Collectively California's independent generators produce more electricity than any comparable group in the U.S.²³ Texas also produces significant amounts of nonutility generated electricity; however in contrast to California (Table 8), two-thirds of it is used by the independent power producers themselves and does not find its way into the Texas grid.

Table 8.²³ Production of electricity by California utilities and nonutilities
(Billion kwh)

	Year	
	1992	1993
Net generation by public utilities	119.3	125.8
Gross* generation by nonutilities	67.0	62.8
Receipts (purchases, exchanges, etc.)	4.4	3.0
Deliveries to utilities	50.5	53.4
Facility Use	13.1	12.4

* Note: The gross-to-net generation conversion factor varies from 0.99 to 0.97 depending on the type of prime mover.²³

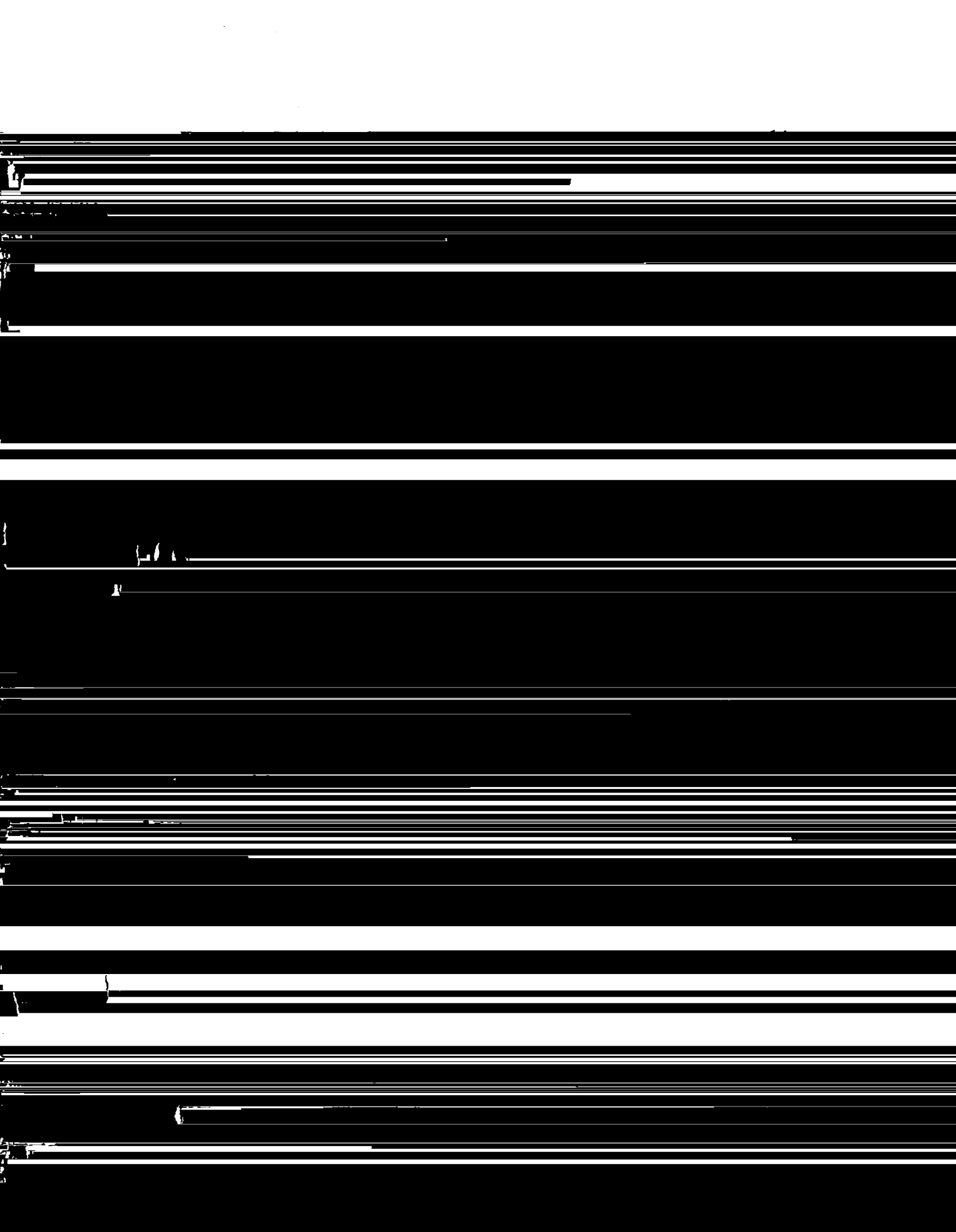
More than half of California nonutility generators are cogenerators.²⁴ The fuel of choice of the cogenerators is overwhelmingly natural gas. The remainder are small power producers who utilize hydropower, wind, biomass, coal coke, solar or geothermal energy to operate qualified facilities that meet certain ownership, operating and efficiency criteria established by the Federal Energy Regulatory Commission pursuant to the Public Utility Regulatory Policies Act of 1978 (PURPA). Geothermal operators are the largest contributor to power production amongst the small power producers. The next largest contributors use biomass residues from lumber operations and food processing (peach pits, husks, etc.) or methane from manure or land fills.²⁵ In Figs. 1 and 2, utility and nonutility production have been combined in the case of geothermal, wind, solar, and hydropower.

The Public Utility Regulatory Policies Act, which encouraged independent power production by requiring the public utilities to purchase nonutility generated electricity, and the Energy Policy Act of 1992, which required the public utilities to transmit electricity generated by the independent power producers, set the stage for radical restructuring of the electrical power industry in the United States. These Acts potentially give independent power producers access to big and small retail customers and give customers the opportunity to choose their supplier. It is not surprising in view of the large size of the nonutility generating industry within the state that within months after the passage of the Energy Policy Act, the California Public Utilities Commission's (CPUC) Division of Strategic Planning began examining the future of electric industry regulation. Its focus was the likely new competition between the theretofore monopolistic public utilities and the independent power generators. By the end of 1993 the CPUC had almost finished formulating a proposal to allow out-of-state utilities to sell power directly to large industrial and commercial users starting in 1996 and to residential users six years later. The intent was to unveil a formal proposal in 1994 for public comment. The objective of the CPUC proposal is to prod the public utilities to improve their efficiencies and cut their costs in order to meet the competition. The CPUC must grapple with the prospect of the likely early loss of some of the utilities' large customers associated with relatively high profit margins and with the specter of compensating increases in the rates of the small users with large service requirements. Irrespective of the exact details of the proposal, one ramification of such change is that utility stocks and bonds, long regarded as stable investments, would become more risky and volatile on the stock and bond market.

Alternate Sources of Electricity

Geothermal

Collective output from the state's geothermal fields was slightly up in 1993 (Table 9) despite continuing decline in steam production (and thus generated electricity) at The Geysers in



additional photoelectric plants with 2 MW capacity in Solano and Sacramento Counties. The output of all of these solar electric plants is put into the utility electric grid; however it is small - approximately 2.7 million kwh.

Windpower

The number of wind turbines operated by nonutilities in the state during 1993 decreased by 3.5% primarily due to changes in the Altamont Pass installations (Table 10). Capacity factors at the Altamont likewise fell from 17% to 14%; however an increase of 4% in capacity factors at windfarms in the Tehachapi Mountains, the second largest installation in the state, more than compensated so that the state wide average rose slightly. The total amount of electricity generated

with the improved turbines to a reputed 5 cents.²⁷ Nonetheless the average for the industry is several cents higher.

Most installations are "qualified facilities" using renewable resources under PURPA and thus eligible for favorable purchase agreements based on "avoided costs" of the utility purchasing the power. The "avoided cost," which is based on fuel and maintenance costs only, has declined substantially in the last decade and with it the cost of power purchases from "qualified facilities." In northern California new "qualified facilities" signing contracts with the utilities received 3-4 cents per kwh in 1993 depending on seasonal factors and time-of-day availability of the power. There is an added 1.5 cents per kwh in the form of a tax credit authorized by the Energy Policy Act of 1992 which improves profitability of new facilities. Many of the old contracts with the utilities pay as much as 10 cents/kwh. According to a Pacific Gas and Electric spokesman, about one-third of their purchases from "qualified facilities" including those from wind generators are associated with older, higher priced (~10 cents/kwh) contracts.²⁸ The latter typically run 10 years, and it was his opinion that most would expire within the next six years.

APPENDIX B

Data Sources for California Energy Supply (1993)

Production

Crude Oil including Federal
Offshore and Lease Condensate

Source

Ref. 14.

Associated and Non associated
Natural Gas (marketed, dry)

Ref. 29, Table 52, Summary Statistics
for Natural Gas - California.

Electric Utility Fuel Data

Ref. 23, Table 18, Consumption of
Petroleum & Natural Gas to Produce
Electricity.

Electrical Generation
Utility -oil, gas, hydro, nuclear,

Ref. 23, Table 13,
Net Generation from Electric Utilities
by energy source.

Wind

Andrea Gough, California Energy
Commission, January 23, 1995.

Cogeneration & various small, nonutility
power producers

Andrea Gough, California Energy
Commission, personal communication,
January 23, 1995 & January 25, 1995.

Imports

Natural Gas
Foreign
Domestic

Ref. 29, Table 9.

Ref. 29, Table 52.

Crude Oil
Foreign and Domestic

Ref. 30, Table 1-A, California
Petroleum Summary.

Oil Products
Foreign and Domestic

Ref. 30, Table A-1, California Fuels
Market Petroleum Activity.

Coal

Ref. 31, Table 46, Coal Consumption
by Census Division and State.

Electrical Power
Net Exchange

Andrea Gough, California Energy
Commission, personal communication,
January 17, 1995.

Coal

Ibid.

Exports

Oil Products
Foreign and Domestic
(not including bunkering fuel
supplied at California ports)

Ref. 30, Table A-1.

APPENDIX C

Data Sources for California End Uses (1993)

Net Storage

Natural Gas

Ref. 29, Table 52

Unaccounted for Natural Gas

Ref. 29, Table 52

Transportation

Crude Oil

Gasoline, Aviation and Jet fuels

Ref. 30 Table 1-A

Taxable Diesel Fuel

Ref. 32, Table 4, Sales for Transportation

APPENDIX D

Conversion Units

Energy Source

Conversion factor, 10⁶ Btu

Electricity	3.415 per million Wh
Coal	22.6 per short ton
Natural Gas	1.05 per Mcf
Crude Oil	5.80 per barrel
Fuel Oil	
Residual	6.287 per barrel
Distillate, including diesel	5.825 per barrel
Gasoline and Aviation Gasoline	5.253 per barrel
Kerosene and Kerosene-type jet fuel	5.67 per barrel
Asphalt	6.636 per barrel
Road Oil	6.636 per barrel
Synthetic Rubber and Miscellaneous	
LPG Products	4.01 per barrel

Assumed Conversion Efficiencies of Primary Energy Supply

Electric Power Generation	
Hydropower	90%
Coal	30%
Geothermal	18%
Oil and Gas	33%
Uranium	32%
Biomass	12%
Transportation Use	20%
Residential/Commercial Use	70%
Industrial Use	75%

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